

WHAT IS CLAIMED IS:

1. An axial-flow fan, comprising:
a main shaft;
a plurality of main fins provided on the outer circumference of the main shaft,
the main fins being inclined relative to an axial direction of the main shaft, where a front end in rotary direction of the main fin is located on an intake side and a rear end in rotary direction of the main fin is located on an exhaust side when the axial-flow fan transfers an air; and
an auxiliary fin provided between mutually adjoining main fins,
wherein the height of the auxiliary fin from the front end to the rear end in rotary direction of the auxiliary fin along the axial direction of the main shaft is not less than the half and not more than four fifths of the height of the main fin from the front end to the rear end of the main fin along the axial direction of the main shaft, and
wherein, when the main fins are arranged by a pitch W , the front end in rotary direction of the auxiliary fin is located within $-1/8 \times W$ to $+1/8 \times W$ along the rotary direction from the front end in rotary direction of the main fin adjoining in reverse rotary direction.
2. The axial-flow fan according to claim 1, wherein the rear end in rotary direction of the auxiliary fin is spaced apart from the rear end in rotary direction of the main fin adjoining in the reverse rotary direction by $1/2 \times W$ in the rotary direction.
3. The axial-flow fan according to claim 1, wherein, when an attachment angle of the auxiliary fin relative to the main shaft is θ_2 and an attachment angle of the main fin relative to the main shaft is θ_1 , the maximum of θ_2 is represented as $\theta_2 = \theta_1 + 5^\circ$.
4. The axial-flow fan according to any one of claims 1 to 3,
wherein the cross section of the main fin along the axial direction of the main shaft is streamlined or is approximately streamlined, and
wherein the cross section of the auxiliary fin is similar or approximately similar to the main fin.
5. The axial-flow fan according to any one of claims 1 to 4, wherein the thickness of the cross section of the auxiliary fin taken along the axial direction of the main shaft is not more than the thickness of the cross section of the main fin taken along the axial direction of the main shaft.
6. The axial-flow fan according to any one of claims 1 to 5, wherein the main fin is arranged to be superposed on the adjoining main fins when being seen from the exhaust side.

7. The axial-flow fan according to any one of claims 1 to 6, wherein a mirrored surface is formed on a positive pressure side and a negative pressure side of the main fin.
8. The axial-flow fan according to any one of claims 1 to 7, further comprising:
a motor that drives the main shaft;
a cylindrical frame that accommodates the main shaft, the main fin, the auxiliary fin and the motor, the frame having openings on the intake side and the exhaust side;
and
a spoke extending from an edge of the opening on the exhaust side of the frame approximately to the center of the opening to hold the motor,
wherein the spoke works as a guide fin in discharging an air transferred by the main fin toward the outside of the frame.
9. The axial-flow fan according to claim 8, wherein the spoke is curved in a direction opposite to the rotary direction of the main fin, and has a curved surface adapted to scoop up the air transferred by the main fin.
10. The axial-flow fan according to claim 8 or 9, wherein the frame is made of metal or a resin having high thermal conductivity.
11. The axial-flow fan according to claim 1, further comprising:
a frame that accommodates the main shaft, the main fin, the auxiliary fin and the motor, the frame having openings on the intake side and the exhaust side; and
a straightening plate having tapered configuration of which diameter becomes greater toward a direction opposite to a direction for transferring the air.
12. The axial-flow fan according to claim 1, further comprising:
a frame that accommodates the main shaft, the main fin, the auxiliary fin and the motor for driving the main shaft, the frame having openings on the intake side and the exhaust side; and
a filter attached on the frame to cover the opening on the intake side.
13. The axial-flow fan according to claim 12, wherein the opening of the filter has polygonal or circular profile, and
wherein the thickness of the filter is not less than 0.1mm and not more than 5mm.
14. The axial-flow fan according to claim 13, wherein the diameter of the opening of the filter is not less than 0.3mm and not more than 3mm, and
wherein the opening ratio of the filter is not less than 70% and not more than 90%.

15. The axial-flow fan according to any one of claims 12 to 14, wherein a predetermined gap is secured between the filter and the opening of the frame.

16. The axial-flow fan according to any one of claims 1 to 15, further comprising:
a frame that accommodates the main shaft, the main fin, the auxiliary fin and the motor for driving the main shaft, the frame having openings on the intake side and the exhaust side; and

a cylindrical cover having a louver attached thereinside, the cover being provided on the exhaust side of the frame,

wherein the louver includes a plurality of louver components extending from the center of the cover to the periphery thereof, the louver components working as a guide fin in discharging an air transferred by the main fin toward the outside of the frame.

17. The axial-flow fan according to claim 16, wherein the louver component is inclined in a direction opposite to the inclination of the main fin.

18. The axial-flow fan according to any one of claims 1 to 15, further comprising:
a frame that accommodates the main shaft, the main fin, the auxiliary fin and the motor for driving the main fin, the frame having openings on the intake side and the exhaust side; and

a cylindrical cover having a louver attached thereinside, the cover being provided on the exhaust side of the frame,

wherein the louver includes a plurality of louver components disposed approximately in parallel, and

wherein the space between the adjoining louver components where light-shielding surfaces of the louver components are approximately orthogonal to the inclination of the main fin is broader than the space between the louver components where the light-shielding surface is approximately parallel to the inclination of the main fin.

19. The axial-flow fan according to any one of claims 16 to 18, wherein a predetermined gap is secured between the louver and the opening of the frame on the exhaust side.

20. A projector, comprising:
an optical system including an optical modulator that modulates a light beam irradiated by a light source in accordance with image information to project the light beam in an enlarged manner to form a projection image, and a fan for circulating an air,

wherein the fan is the axial-flow fan according to any one of claims 1 to 19.